



US009221186B2

(12) **United States Patent**
Scaroni et al.

(10) **Patent No.:** **US 9,221,186 B2**
(45) **Date of Patent:** **Dec. 29, 2015**

(54) **PRODUCE PROCESSING APPARATUS**

(76) Inventors: **David W. Scaroni**, Heber, CA (US);
Matthew S. Scaroni, Heber, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 727 days.

(21) Appl. No.: **12/948,605**

(22) Filed: **Nov. 17, 2010**

(65) **Prior Publication Data**

US 2011/0081463 A1 Apr. 7, 2011

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/421,498, filed on Apr. 9, 2009, now abandoned.

(51) **Int. Cl.**

A23F 5/00 (2006.01)
A23L 1/00 (2006.01)
B26D 7/14 (2006.01)
B26D 1/143 (2006.01)
B26D 3/26 (2006.01)
A23N 15/00 (2006.01)
B26D 7/06 (2006.01)

(52) **U.S. Cl.**

CPC **B26D 7/14** (2013.01); **A23N 15/003** (2013.01); **B26D 1/143** (2013.01); **B26D 3/26** (2013.01); **B26D 7/0625** (2013.01); **Y10T 83/654** (2015.04); **Y10T 83/6579** (2015.04)

(58) **Field of Classification Search**

CPC A47J 43/00; A47J 43/26; A47J 21/00; A47J 23/00; A47J 25/00; A23N 5/00; A23N 5/004; A23N 5/006; A23N 5/008; A23N 5/01; A23N 5/03; A23N 5/08; A23N 4/00; A23N 4/02; A23N 4/04; A23N 4/06; A23N 4/08; A23N 4/085; A23N 4/10; A23N 4/12; A23N

4/14; A23N 4/16; A23N 4/18; A23N 4/20; A23N 4/22; A23N 4/24; A23N 7/00; A23N 7/002; A23N 7/005; A23N 2007/007; A23N 7/01; A23N 7/02; A23N 7/023; A23N 7/026; A23N 7/04; A23N 7/08; A23N 7/10; A23N 15/02; A23N 15/003; A23N 15/025; A23N 15/06; A01D 46/285; A24B 15/284
USPC 99/535, 537–539, 546, 626, 627, 635; 56/12.4, 12.5; 171/8, 30, 40–42; 426/302

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,031,669 A * 7/1912 Twamley 356/432
1,861,084 A * 5/1932 Goranson et al. 99/541
2,141,806 A * 12/1938 Zielesch 56/121.4
2,158,545 A * 5/1939 Kieweg 99/553

(Continued)

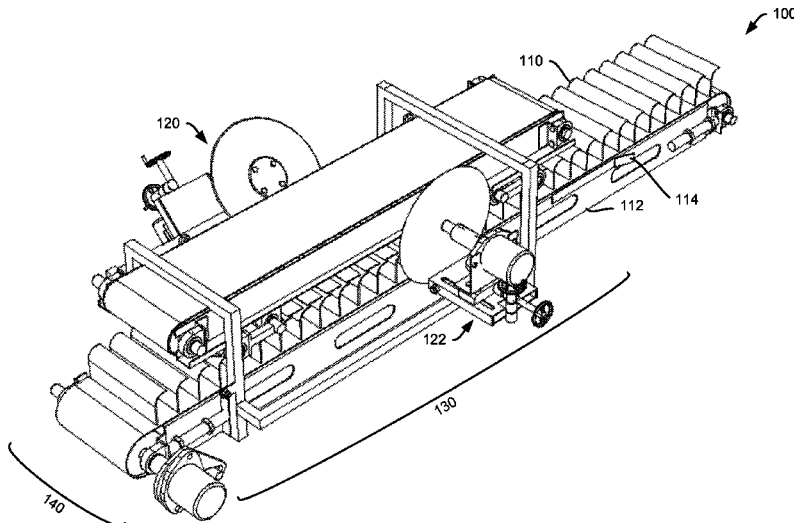
Primary Examiner — Eric Stapleton

(74) *Attorney, Agent, or Firm* — Kali Law Group P.C.

(57) **ABSTRACT**

Produce processing apparatuses are presented including: a number of paddles coupled with a rotating conveyor system configured for capturing and securing produce along a first position; a counter-rotating compression belt system for compressing the produce along a second position, where the counter-rotating compression belt system is configured to apply a compressive force to the produce such that the produce is secured, and where the counter-rotating compression belt system includes a belt that is counter-rotating and synchronized with respect to the rotating conveyor system; and a cutting system including a rotary coring blade assembly positioned along a path of the rotating conveyor system, where the rotary coring blade assembly is positioned and configured to core the produce along a third position.

15 Claims, 10 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

2,187,326	A *	1/1940	Nicoll et al.	99/563	5,245,188	A *	9/1993	Satake et al.	250/341.7
2,232,208	A *	2/1941	Carroll	99/486	5,252,240	A *	10/1993	Eusebi	252/76
2,232,209	A *	2/1941	Carroll	99/549	5,376,047	A *	12/1994	Harden et al.	460/121
2,236,002	A *	3/1941	Lederer	56/14.6	5,410,955	A *	5/1995	Paterson et al.	99/543
2,299,137	A *	10/1942	Geren et al.	99/544	5,448,069	A *	9/1995	Tobler et al.	250/339.01
2,300,773	A *	11/1942	Carroll	99/635	5,470,602	A *	11/1995	Cecil	426/481
2,456,372	A *	12/1948	Buechek	426/297	5,524,746	A *	6/1996	Massen et al.	198/443
2,649,878	A *	8/1953	Coons	99/627	5,659,624	A *	8/1997	Fazzari et al.	382/110
3,101,042	A *	8/1963	Good	99/487	5,669,511	A *	9/1997	Satake et al.	209/580
3,197,647	A *	7/1965	Fraenkel	250/225	5,733,592	A *	3/1998	Wettstein et al.	426/416
3,199,558	A *	8/1965	Anderson et al.	99/545	5,780,088	A *	7/1998	Zittel et al.	426/483
3,216,567	A *	11/1965	Kelly et al.	209/571	5,865,111	A *	2/1999	Hanson	99/637
3,380,500	A *	4/1968	Alpen	99/637	5,865,990	A *	2/1999	Novak et al.	209/579
3,382,900	A *	5/1968	De Back	99/542	5,924,271	A *	7/1999	Truffaux	56/327.1
3,455,445	A *	7/1969	Allen et al.	209/544	5,973,286	A *	10/1999	Wan	209/582
3,478,794	A *	11/1969	Alpen	99/637	6,036,989	A *	3/2000	Ellis	426/484
3,478,795	A *	11/1969	Thornsbery	99/639	6,059,117	A *	5/2000	Novak et al.	209/10
3,581,888	A *	6/1971	Kelly et al.	209/565	6,119,442	A *	9/2000	Hale	56/10.2 H
3,646,977	A *	3/1972	Goodale	99/635	6,237,475	B1 *	5/2001	Ascari et al.	99/543
3,690,049	A *	9/1972	Roberson et al.	56/13.9	6,252,188	B1 *	6/2001	Zapata et al.	209/577
3,695,323	A *	10/1972	Akesson et al.	99/637	6,368,649	B1 *	4/2002	van Bommel	426/482
3,724,470	A *	4/1973	Wilson	132/212	6,382,394	B1 *	5/2002	Matsushita et al.	198/395
3,871,774	A *	3/1975	Murata	356/432	6,449,932	B1 *	9/2002	Cooper et al.	56/10.2 R
3,886,857	A *	6/1975	Goodale	99/563	6,526,120	B1 *	2/2003	Gray et al.	378/57
3,907,101	A *	9/1975	Tomelleri	198/375	6,607,769	B1 *	8/2003	Krymskiy et al.	426/484
3,952,646	A *	4/1976	Leban	99/639	6,736,041	B2 *	5/2004	Portnoy	83/404.1
3,956,636	A *	5/1976	Williams	250/559.4	6,814,994	B2 *	11/2004	Blasco Piquer et al.	426/482
4,038,426	A *	7/1977	Jespersen et al.	426/266	6,882,434	B1 *	4/2005	Sandberg et al.	356/601
4,041,672	A *	8/1977	Gularte	53/399	6,966,162	B2 *	11/2005	Viaud et al.	53/64
4,095,391	A *	6/1978	Anguiano	53/515	6,996,964	B2 *	2/2006	Maconachy et al.	56/327.1
4,127,193	A *	11/1978	Richardson	209/539	7,008,366	B1 *	3/2006	Aitkenhead et al.	494/18
4,161,366	A *	7/1979	Bol et al.	356/56	7,062,899	B2 *	6/2006	Maconachy et al.	56/327.1
4,168,642	A *	9/1979	Evans	83/404.3	7,335,847	B2 *	2/2008	Drewes et al.	209/587
4,176,750	A *	12/1979	Holmes	171/28	7,367,880	B2 *	5/2008	Hoskinson et al.	460/5
4,196,811	A *	4/1980	Pilesi et al.	209/588	7,450,247	B2 *	11/2008	Sandberg et al.	356/601
4,211,161	A *	7/1980	Jourdan et al.	99/638	7,452,323	B2 *	11/2008	Aitkenhead et al.	494/45
4,287,820	A *	9/1981	Urban	99/538	7,540,129	B2 *	6/2009	Kormann	56/10.2 E
4,348,855	A *	9/1982	DePauw et al.	460/1	7,623,249	B2 *	11/2009	Sandberg et al.	356/601
4,371,081	A *	2/1983	Satake	209/580	7,721,637	B2 *	5/2010	Bucks	83/663
4,412,483	A *	11/1983	Hoegh	99/538	7,887,865	B2 *	2/2011	Knorr et al.	426/484
4,420,118	A *	12/1983	Gehlen	241/101.2	7,906,162	B2 *	3/2011	Woelfel	426/289
4,441,513	A *	4/1984	Herwig	460/1	8,047,381	B2 *	11/2011	Koyama et al.	209/539
4,455,929	A *	6/1984	Goudarzi et al.	99/637	8,061,527	B2 *	11/2011	Koyama et al.	209/539
4,480,536	A *	11/1984	Burns	100/6	8,100,268	B2 *	1/2012	Deefholts	209/655
4,572,666	A *	2/1986	Satake	356/239.1	8,216,120	B2 *	7/2012	Aitkenhead et al.	494/45
4,601,156	A *	7/1986	Parry et al.	53/399	8,247,724	B2 *	8/2012	Mills et al.	209/576
4,658,714	A *	4/1987	McIlvain et al.	99/637	8,336,434	B2 *	12/2012	Sandberg et al.	83/364
4,666,045	A *	5/1987	Gillespie et al.	209/585	8,387,522	B2 *	3/2013	Rusko et al.	99/540
4,674,270	A *	6/1987	Tonus	53/556	2005/0126144	A1 *	6/2005	Koselka et al.	56/10.2 R
4,699,273	A *	10/1987	Suggi-Liverani et al.	209/580	2005/0204717	A1 *	9/2005	Colens	56/344
4,713,781	A *	12/1987	Brizgis et al.	382/110	2006/0021317	A1 *	2/2006	Costa et al.	56/327.1
4,752,689	A *	6/1988	Satake	250/339.07	2006/0213167	A1 *	9/2006	Koselka et al.	56/10.2 A
4,773,324	A *	9/1988	Wylie et al.	99/638	2007/0095041	A1 *	5/2007	de Groot et al.	56/13.5
4,806,764	A *	2/1989	Satake	250/339.07	2007/0214763	A1 *	9/2007	Nash et al.	56/327.1
5,009,909	A *	4/1991	Hirtle et al.	426/481	2007/0221072	A1 *	9/2007	de Groot et al.	99/537
5,138,940	A *	8/1992	Geissler et al.	99/538	2008/0022828	A1 *	1/2008	Bucks	83/591
5,168,801	A *	12/1992	Switek, Jr.	99/546	2008/0245243	A1 *	10/2008	Rusko et al.	99/537
5,174,181	A *	12/1992	Julian et al.	83/24	2009/0044505	A1 *	2/2009	Huster et al.	56/10.2 R
5,181,458	A *	1/1993	Plant et al.	99/538	2009/0145272	A1 *	6/2009	Sandberg et al.	83/13
					2009/0173196	A1 *	7/2009	Lindee et al.	83/13

* cited by examiner

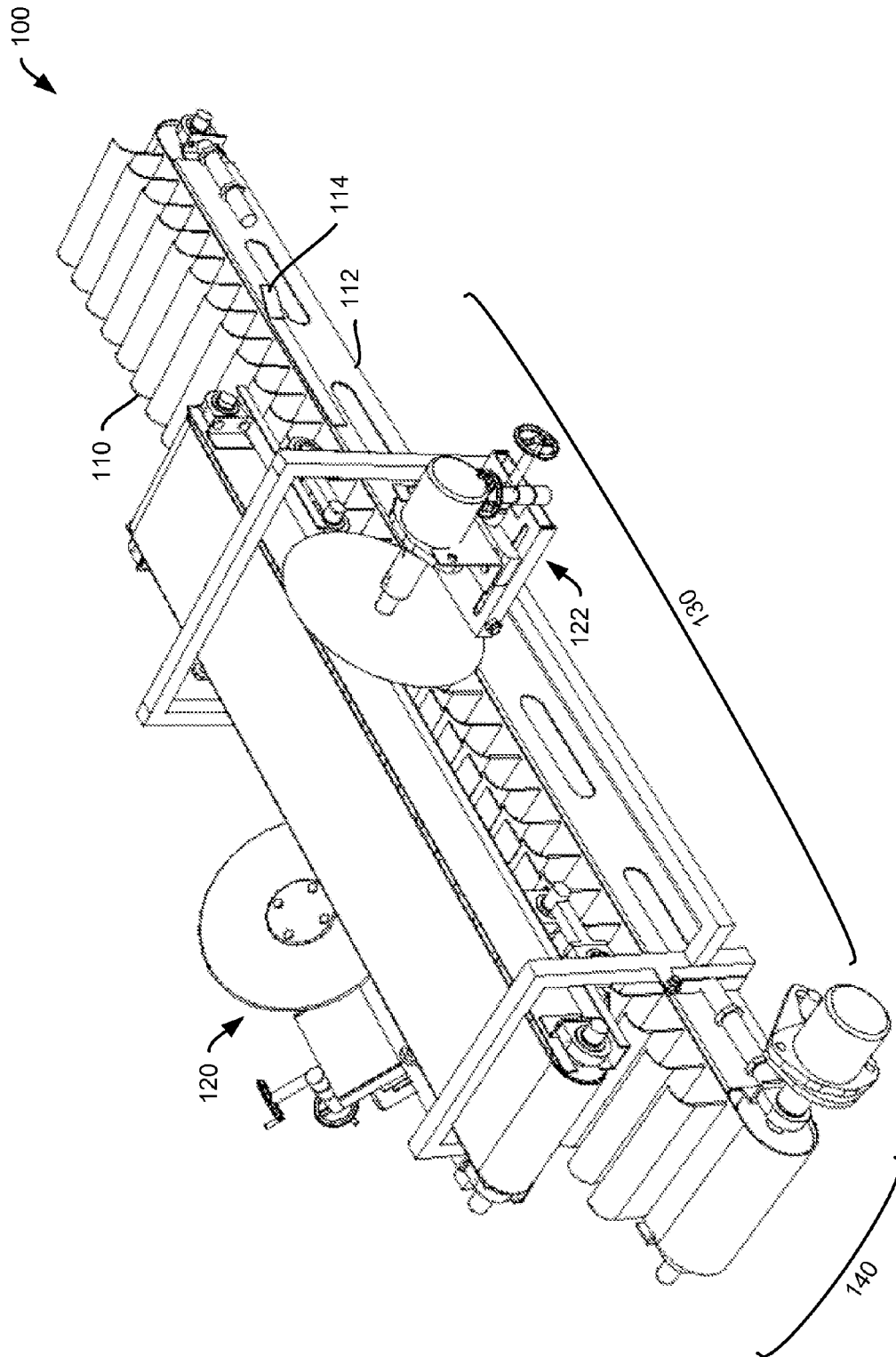
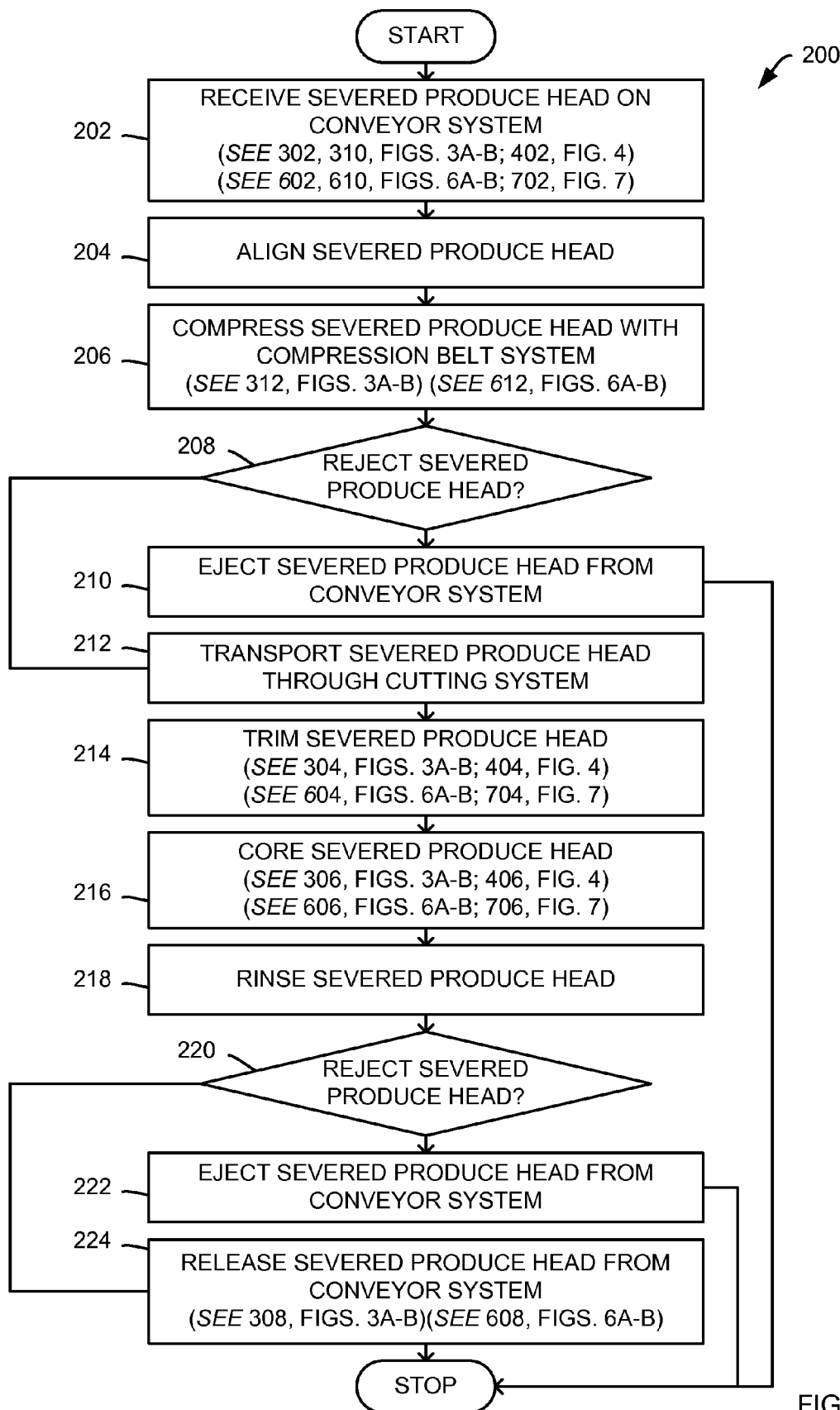
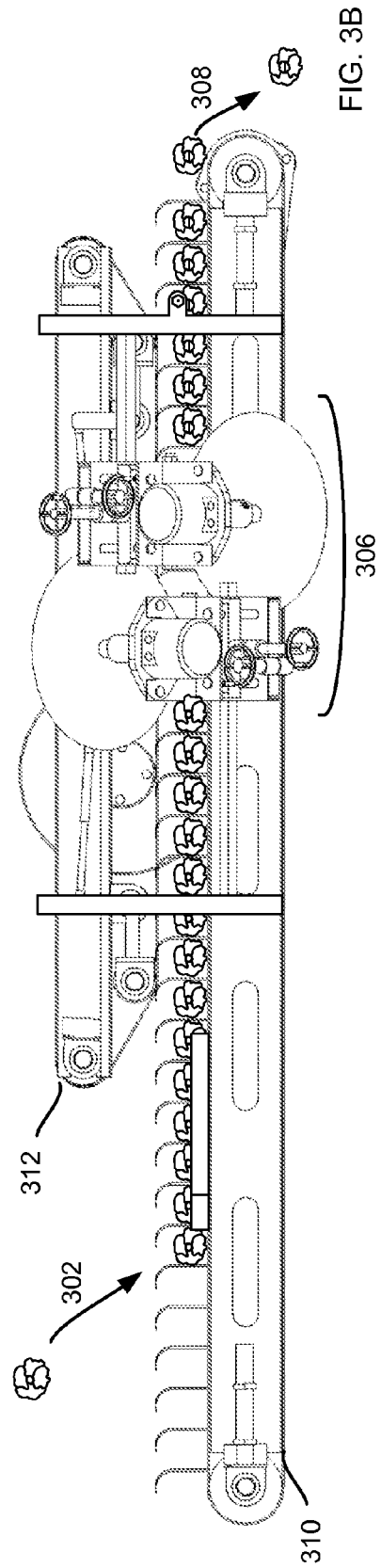
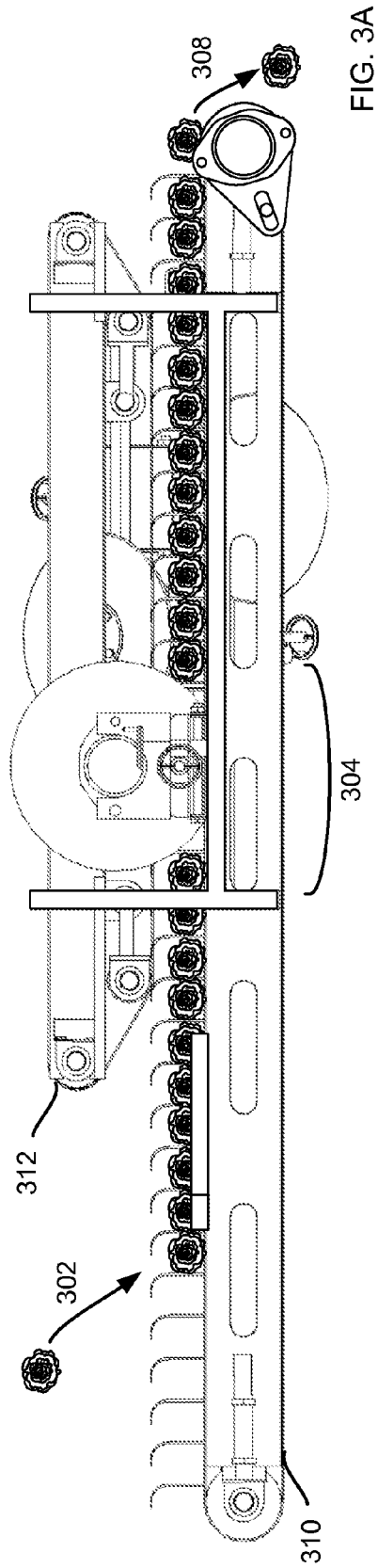


FIG. 1





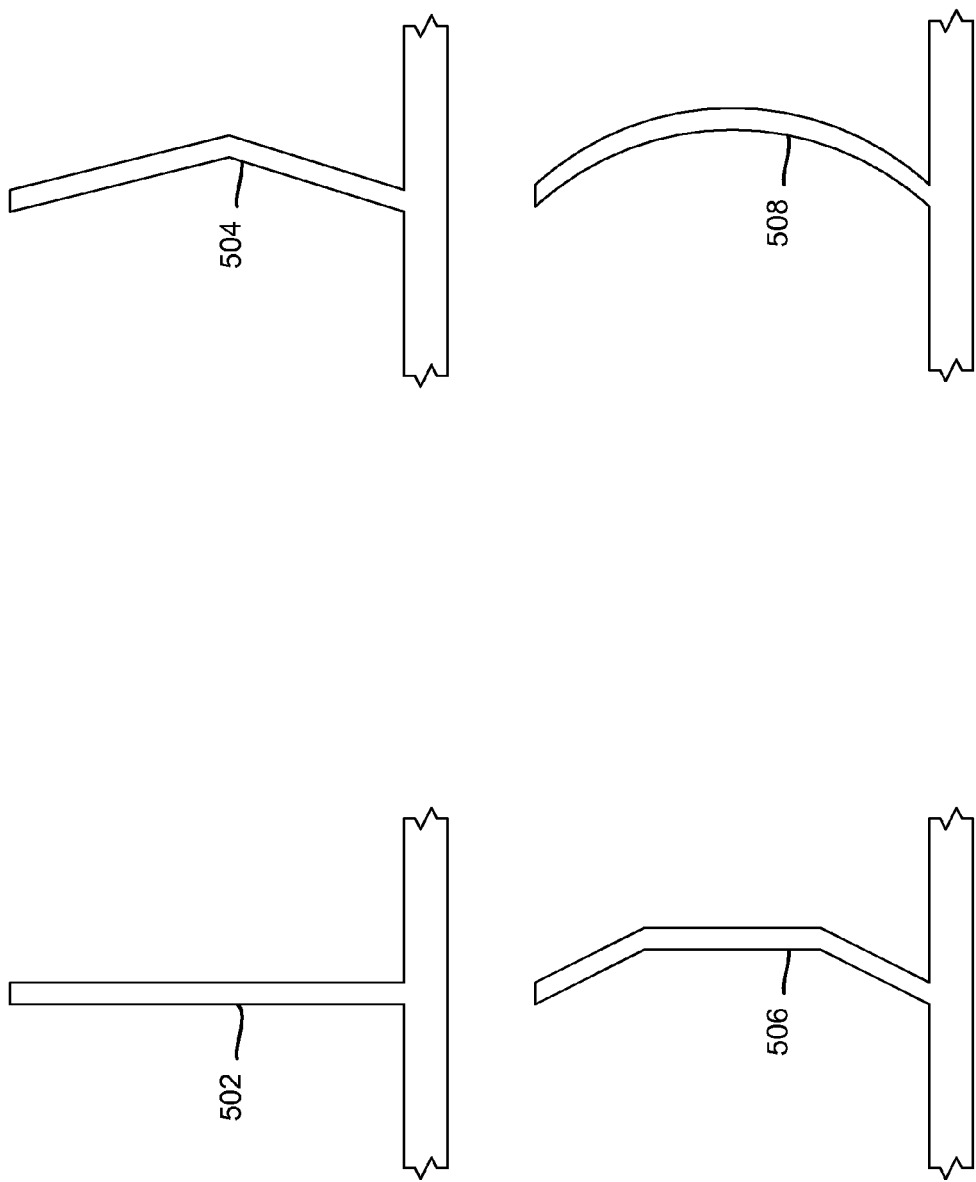


FIG. 5

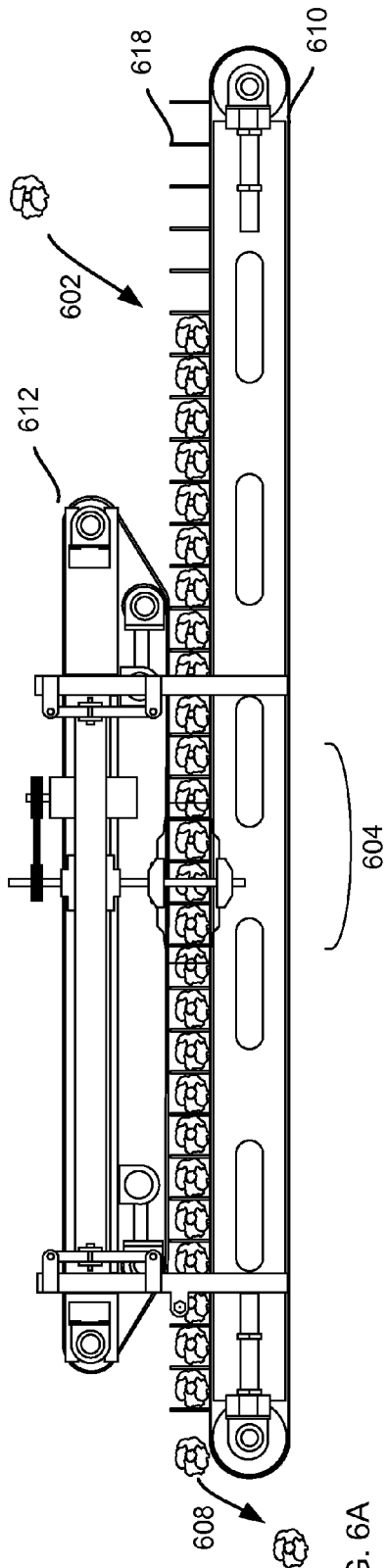


FIG. 6A



FIG. 7

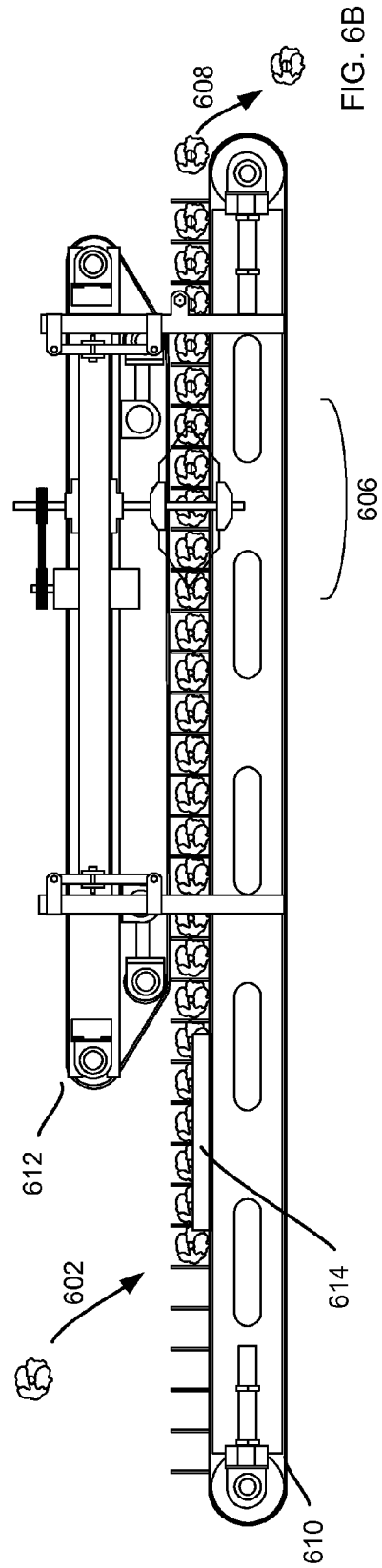


FIG. 6B

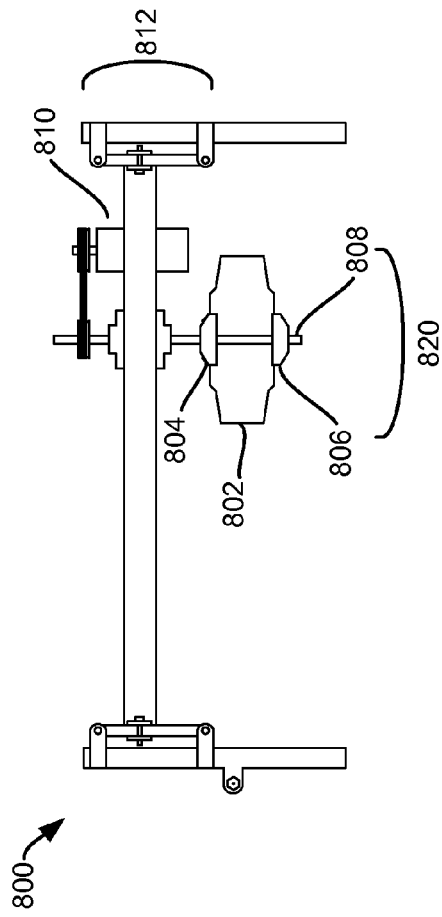


FIG. 8A



FIG. 9

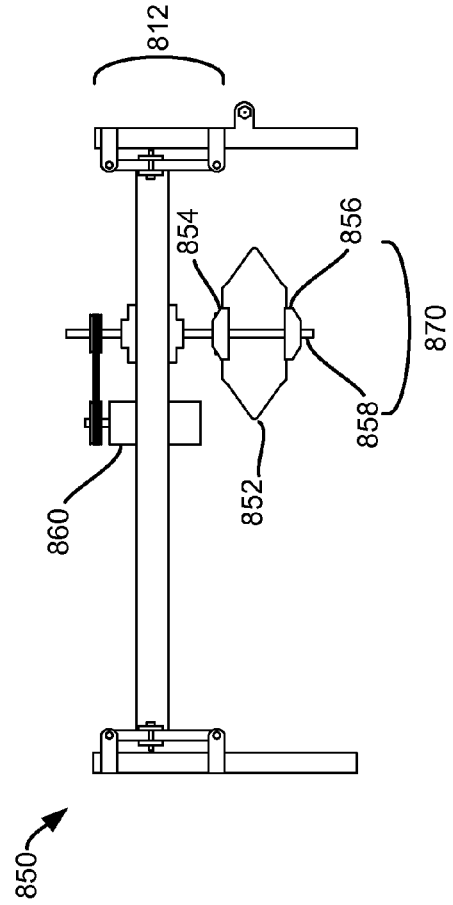


FIG. 8B

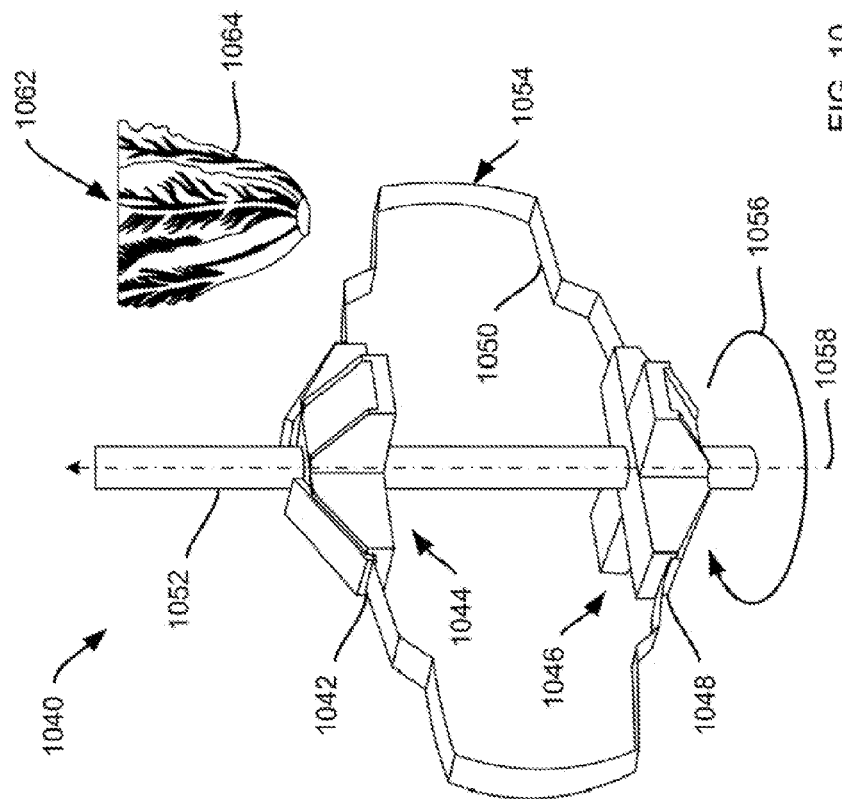
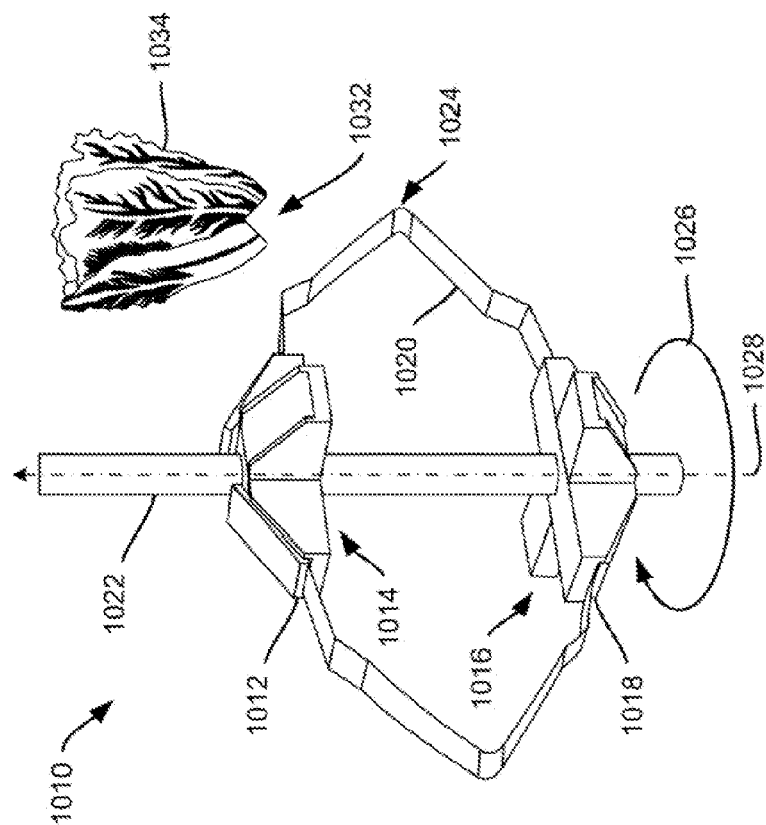


FIG. 10

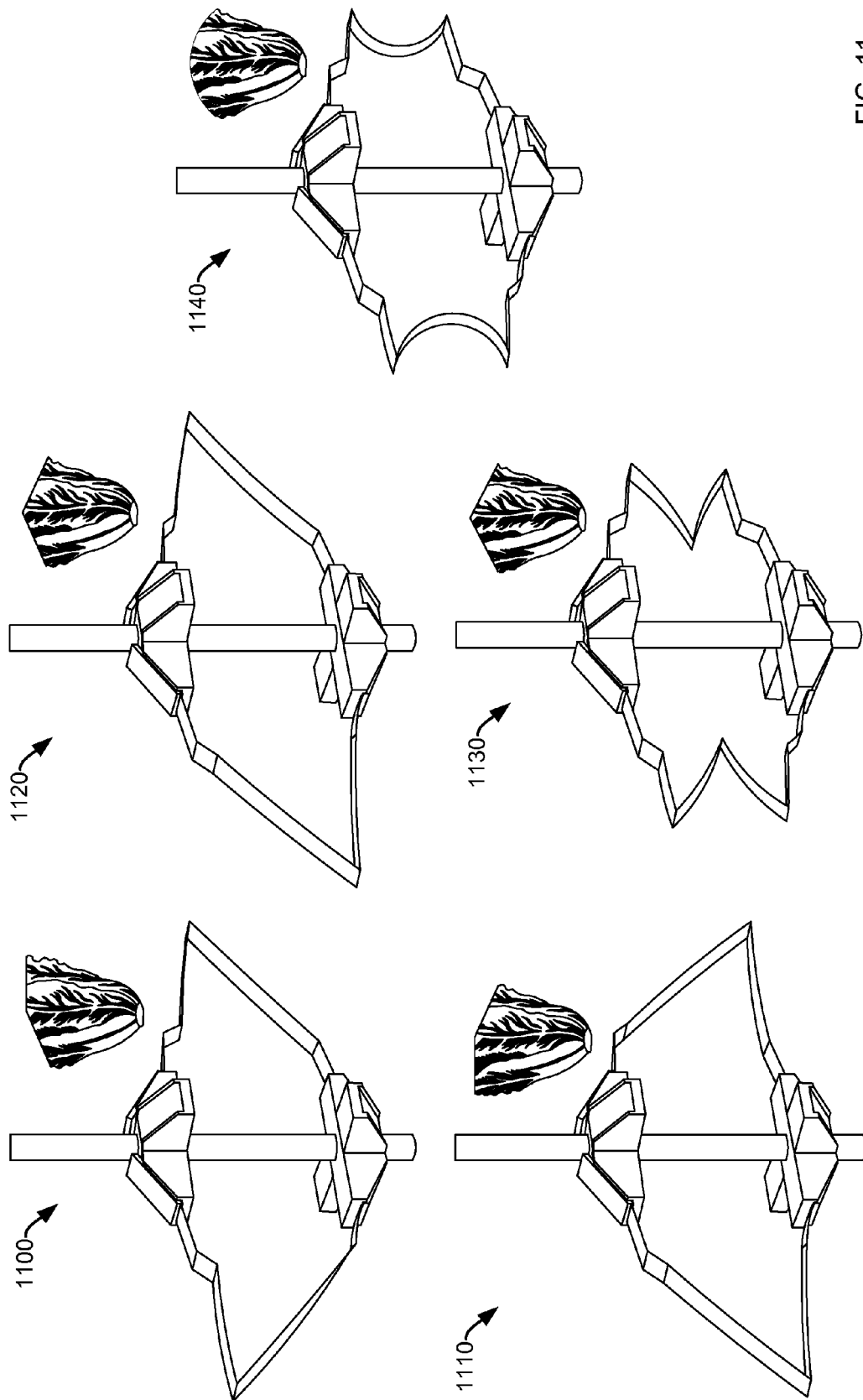
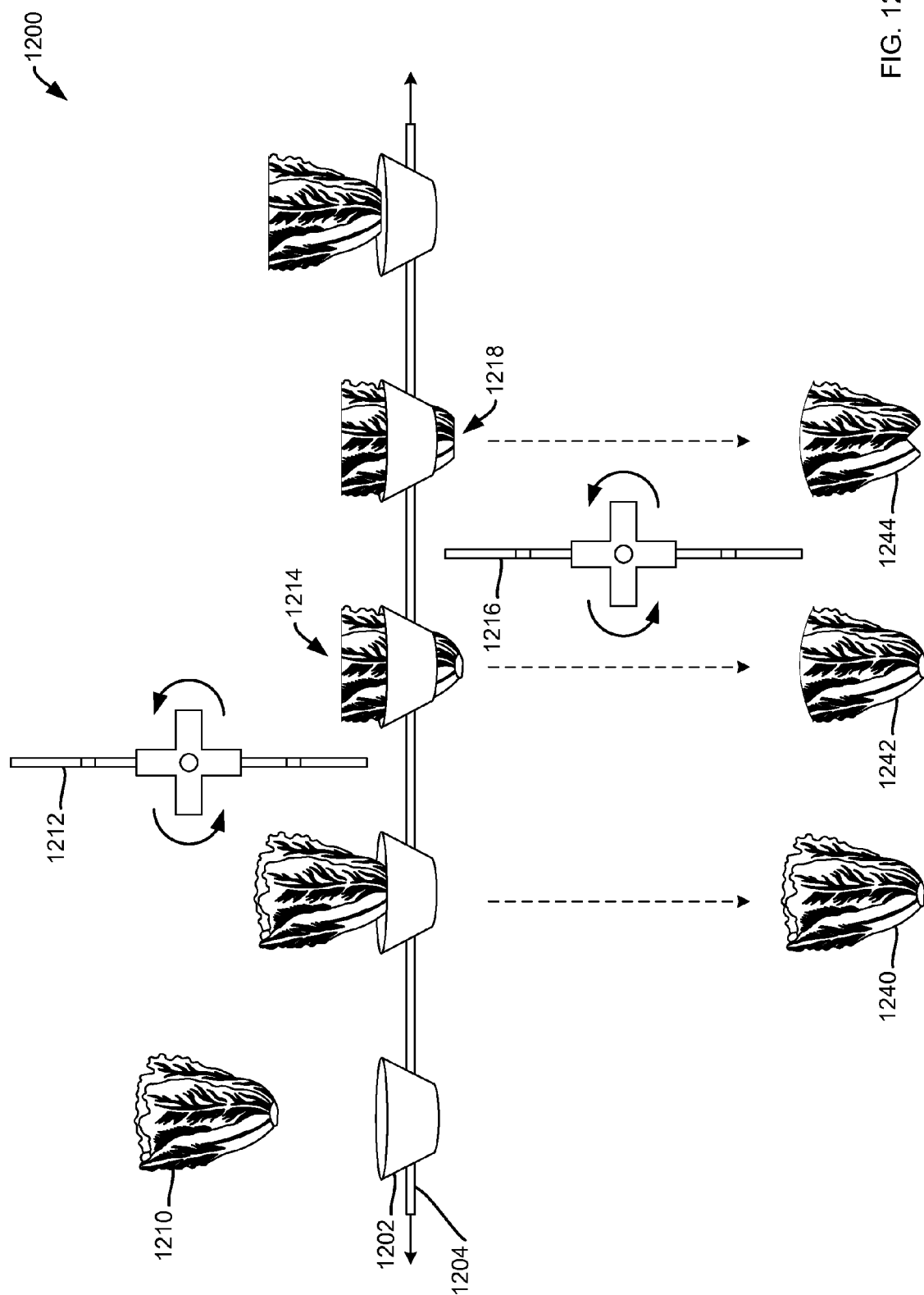


FIG. 11



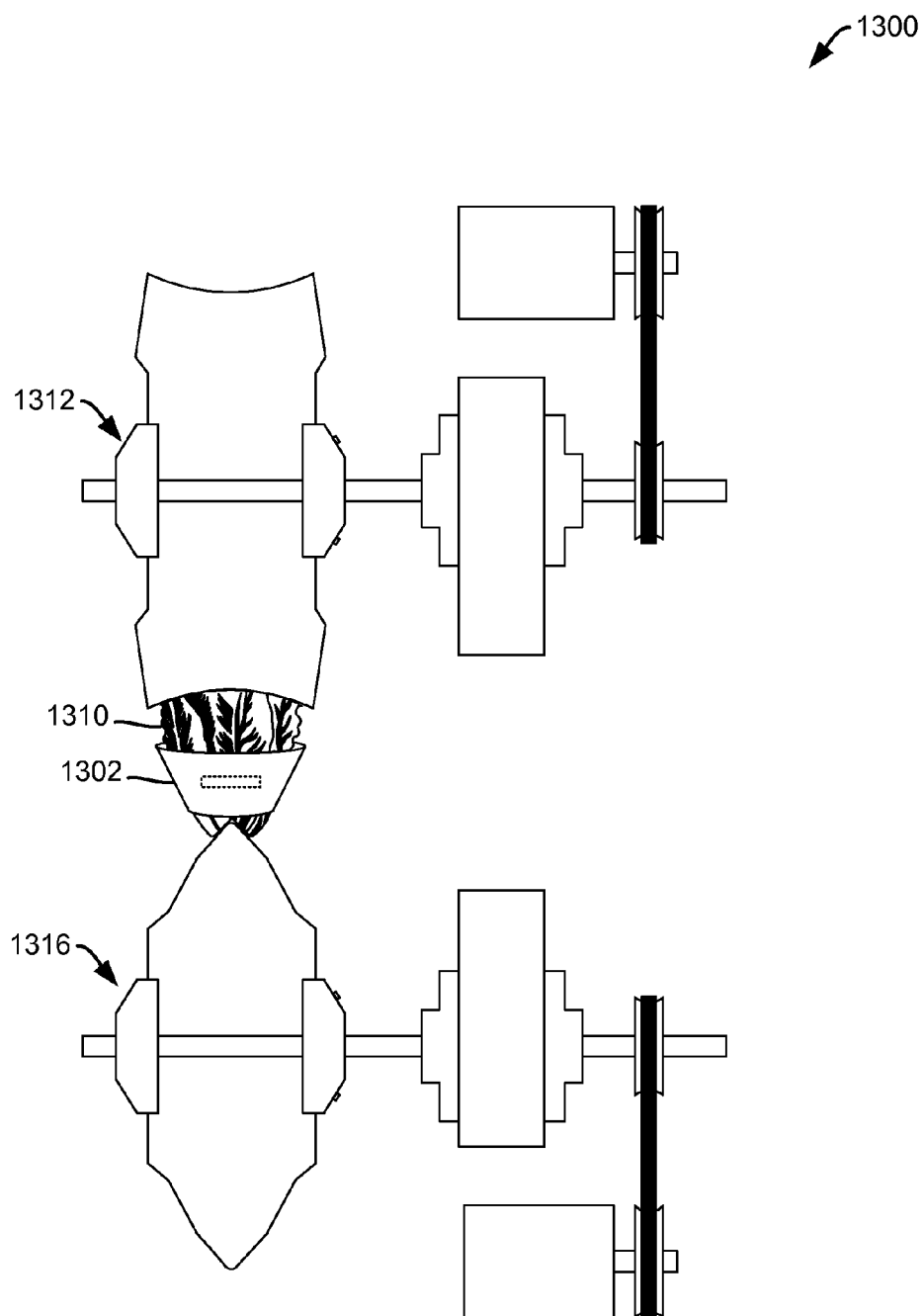


FIG. 13

1

PRODUCE PROCESSING APPARATUS**PRIORITY CLAIM TO CO-PENDING
APPLICATION**

A claim for priority is hereby made under the provisions of 35 U.S.C. §120 for the present application, which is a continuation-in-part of U.S. application Ser. No. 12/421,498, filed on Apr. 9, 2009, which is incorporated herein by reference.

BACKGROUND

Embodiments of the present invention relate to methods and apparatus for harvesting produce. In particular, methods may be utilized for automated trimming and coring operations.

Modern farming techniques provide many automated methods for harvesting produce. Automated methods have resulted in more efficient utilization of farming resources. For example, automated methods have increased uniformity and quality in produce processing while simultaneously reducing the number of personnel required for accomplishing that production. As a result of automation, delivery of plentiful and low cost products to market is made possible.

In some farming processes, however, some manual labor is still required. For example, in harvesting delicate produce such as leafy vegetables—hand picking, sorting, and processing is still being utilized in field. In a typical field, numerous personnel are required to maintain harvesting production. As may be appreciated, the costs associated with managing large workforces directly affect market prices. In addition, human error and inconsistency may result, in some examples, in non-uniform production which could adversely affect consumer satisfaction.

At least one problem associated with harvesting delicate produce automatically is that the produce may be easily damaged. For example, lettuce is one type of delicate produce. During production, lettuce must be sufficiently secured without damaging the leaves which is the end product. In many cases, field processing may be desirable to lower overall production costs, however, equipment must be both sufficiently robust to handle field environments as well as sufficiently sensitive to handle produce without damage—two goals which are often in direct opposition with one another.

Another problem in harvesting delicate produce automatically is that selection of viable produce is critical. Typically, a laborer examines a head of lettuce to determine whether the produce is viable as a market product. The laborer may then accept or reject the produce before harvesting. However, viability is necessarily a subjective assessment and is thus continually subject to human error. As may be appreciated, these errors may lead either to non-viable product reaching market, or viable product being lost in the field.

As such produce processing apparatus are presented herein.

SUMMARY

The following presents a simplified summary of some embodiments of the invention in order to provide a basic understanding of the invention. This summary is not an extensive overview of the invention. It is not intended to identify key/critical elements of the invention or to delineate the scope of the invention. Its sole purpose is to present some embodiments of the invention in a simplified form as a prelude to the more detailed description that is presented below.

2

As such, produce processing apparatuses are presented including: a number of paddles coupled with a rotating conveyor system configured for capturing and securing produce along a first position; a counter-rotating compression belt system for compressing the produce along a second position, where the counter-rotating compression belt system is configured to apply a compressive force to the produce such that the produce is secured, and where the counter-rotating compression belt system includes a belt that is counter-rotating and synchronized with respect to the rotating conveyor system; and a cutting system including a rotary coring blade assembly positioned along a path of the rotating conveyor system, where the rotary coring blade assembly is positioned and configured to core the produce along a third position. In some embodiments, the rotary coring blade assembly further includes: at least one coring blade, the at least one coring blade including a core blade edge aligned along a core blade leading edge of a first portion of the at least one coring blade, where the first portion is formed to provide a first coring shape to core the produce; a first proximal attachment point for attaching the at least one coring blade with a rotatable coring shaft; and a first distal attachment point for attaching the at least one coring blade with the rotatable coring shaft, where the rotatable coring shaft includes a number of coupling members for removably securing the at least one coring blade at the first proximal attachment point and the first distal attachment point. In some embodiments, the cutting system further includes: a coring drive in mechanical communication with the rotatable coring shaft for driving the at least one cutting blade through a rotational path. In some embodiments, a coring counterweight coupled with the rotatable coring shaft for balancing the cutting system when only one coring blade is utilized. In some embodiments, a second of the at least one coring blade is formed to provide a second coring shape selected from the group consisting of: a similar coring shape, a dissimilar coring shape, and a complimentary coring shape. In some embodiments, the first coring shape and the second coring shape is a shape such as a vee shape, an arcuate shape, a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape. In some embodiments, apparatuses further include: a rotary trimming blade assembly positioned along the path of the rotating conveyor system, the rotary trimming blade assembly including, at least one trimming blade, where the at least one trimming blade further includes: at least one trim blade edge aligned along a trim blade leading edge of a second portion of the at least one trimming blade, where the second portion is formed to provide a first trimming shape to trim the produce, a second proximal attachment point for attaching the at least one trimming blade with a rotatable trimming shaft, and a second distal attachment point for attaching the at least one trimming blade with the rotatable trimming shaft, where the rotatable trimming shaft includes a number of coupling members for securing the at least one trimming blade at the second proximal attachment point and the second distal attachment point. In some embodiments, the produce includes a romaine lettuce head, an iceberg lettuce head, a butterhead lettuce head, a summertime lettuce head, a cabbage head, a bok choy head, an escarole lettuce head, a radicchio lettuce head, a broccoli head, a cauliflower head, a broccoflower head, a celery bunch, and a carrot bunch. In some embodiments, apparatuses further include: a rinse system along a fourth position for rinsing a trimmed and cored produce, where the rinse system includes a rinse selected from the group consisting of: a water rinse, a saline rinse, a chemical rinse, and an air rinse. In some embodiments, apparatuses further include: a first optical detection device along the first position for detecting viability of the produce, the

optical detection device configured to function in coordination with a first produce rejection system along the first position, where the produce is removed from the rotating conveyor system if the produce is not viable. In some embodiments, apparatuses further include: a second optical detection device along fourth position for detecting viability of the produce, the optical detection device configured to function in coordination with a second produce rejection system where the produce is removed from the rotating conveyor system if the produce is not viable.

In other embodiments, methods for coring and trimming produce are presented, the methods including: receiving severed produce on a rotating conveyor system along a first position, the rotating conveyor system including a number of paddles for capturing and securing the severed produce; compressing the severed produce with a counter-rotating compression belt system configured to apply a compressive force to the severed produce such that the severed produce is secured; and transporting the severed produce through a cutting system including, the cutting system including, at least one coring blade positioned along a path of the rotating conveyor system, where the at least one coring blade is positioned and configured to core the severed produce along a second position, and at least one trimming blade positioned along the path of the rotating conveyor system, where the at least one trimming blade is positioned and configured to trim the severed produce along a third position; and releasing a cored and trimmed produce to a collection point. In some embodiments, the at least one coring blade further includes: at least one core blade edge aligned along a core blade leading edge of a first portion of the at least one coring blade, where the first portion is formed to provide a first coring shape to core the produce; a first proximal attachment point for attaching the at least one coring blade with a rotatable coring shaft; and a first distal attachment point for attaching the at least one coring blade with the rotatable coring shaft, where the rotatable coring shaft includes a number of coupling members for removably securing the at least one coring blade at the first proximal attachment point and the first distal attachment point, and where the at least one trimming blade further includes: at least one trim blade edge aligned along a trim blade leading edge of a second portion of the at least one trimming blade, where the second portion is formed to provide a first trimming shape to trim the produce; a second proximal attachment point for attaching the at least one trimming blade with a rotatable trimming shaft; and a second distal attachment point for attaching the at least one trimming blade with the rotatable trimming shaft, where the rotatable trimming shaft includes a number of coupling members for securing the at least one trimming blade at the second proximal attachment point and the second distal attachment point. In some embodiments, methods further include aligning the severed produce with the rotating conveyor system along the first position. In some embodiments, methods further include optically detecting viability of the severed produce before the compressing the severed produce; and rejecting the severed produce if the severed produce is not viable. In some embodiments, methods further include optically detecting viability of the trimmed and cored produce after the transporting the severed produce through a cutting system; and rejecting the trimmed and cored produce if the trimmed and cored produce is not viable. In some embodiments, methods further include rinsing the trimmed and cored severed produce, where the rinsing includes: a water rinse, a saline rinse, a chemical rinse, and an air rinse.

In other embodiments, produce processing apparatuses are presented including: a number of annular cups coupled with a

rotating conveyor system configured for capturing and securing produce along a first position; a cutting system including a rotary coring blade assembly positioned along a path of the rotating conveyor system, where the rotary coring blade assembly is positioned and configured to core the produce along a second position a rotary trimming blade assembly positioned along the path of the rotating conveyor system, where the rotary trimming blade assembly is positioned and configured to core the produce along a third position. In some embodiments, the rotary coring blade assembly further includes: at least one coring blade, the at least coring blade including a core blade edge aligned along a core blade leading edge of a first portion of the at least one coring blade, where the first portion is formed to provide a coring shape to core the produce; a first proximal attachment point for attaching the at least one coring blade with a rotatable coring shaft; and a first distal attachment point for attaching the at least one coring blade with the rotatable coring shaft, where the rotatable coring shaft includes a number of coupling members for removably securing the at least one coring blade at the first proximal attachment point and the first distal attachment point, and where the rotary trimming blade assembly further includes: at least one trim blade edge aligned along a trim blade leading edge of a second portion of the at least one trimming blade, where the second portion is formed to provide a trimming shape to trim the produce, a second proximal attachment point for attaching the at least one trimming blade with a rotatable trimming shaft, and a second distal attachment point for attaching the at least one trimming blade with the rotatable trimming shaft, where the rotatable trimming shaft includes a number of coupling members for securing the at least one trimming blade at the second proximal attachment point and the second distal attachment point.

In other embodiments, methods for processing produce are presented, the methods including: receiving severed produce on a rotating conveyor system along a first position, the rotating conveyor system including a number of annular cups for capturing and securing the severed produce; transporting the severed produce through a cutting system including, the cutting system including, at least one coring blade positioned along a path of the rotating conveyor system, where the at least one coring blade is positioned and configured to core the severed produce along a second position, and at least one trimming blade positioned along the path of the rotating conveyor system, where the at least one trimming blade is positioned and configured to trim the severed produce along a third position; and releasing a cored and trimmed produce to a collection point.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings and in which like reference numerals refer to similar elements and in which:

FIG. 1 is an illustrative representation of a perspective view of a produce processing apparatus in accordance with embodiments of the present invention;

FIG. 2 is an illustrative flowchart of methods for processing produce in accordance with embodiments of the present invention;

FIGS. 3A-B are illustrative representations of side views of a produce processing apparatus during processing in accordance with embodiments of the present invention;

FIG. 4 is an illustrative representation of a unit of processed produce in accordance with embodiments of the present invention;

5

FIG. 5 is an illustrative representation of various paddle shapes in accordance with embodiments of the present invention;

FIGS. 6 A-B are illustrative representations of side views of a produce processing apparatus during processing in accordance with embodiments of the present;

FIG. 7 is an illustrative representation of a unit of processed produce in accordance with embodiments of the present invention;

FIGS. 8 A-B are illustrative representations of side views of a cutting system in accordance with embodiments of the present invention;

FIG. 9 is an illustrative representation of a unit of processed produce in accordance with embodiments of the present invention;

FIG. 10 are illustrative representations of coring and trimming blade assemblies in accordance with embodiments of the present invention;

FIG. 11 is an illustrative representation of trimming blade assemblies in accordance with embodiments of the present invention;

FIG. 12 is an illustrative representation of coring and trimming blade assemblies in accordance with embodiments of the present invention; and

FIG. 13 is an illustrative representation of coring and trimming blade assemblies in accordance with embodiments of the present invention.

DETAILED DESCRIPTION

The present invention will now be described in detail with reference to a few embodiments thereof as illustrated in the accompanying drawings. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art, that the present invention may be practiced without some or all of these specific details. In other instances, well known process steps and/or structures have not been described in detail in order to not unnecessarily obscure the present invention.

FIG. 1 is an illustrative representation of a perspective view of a produce processing apparatus 100 in accordance with embodiments of the present invention. In particular, FIG. 1 is provided to illustrate the various systems required for processing apparatus 100. As such, processing apparatus 100 includes a plurality of paddles 110 for capturing and securing severed produce. As illustrated, paddles may be configured, in some embodiments, having a semi-arcuate shape. Referring briefly to FIG. 5, which is an illustrative representation of various paddle shapes in accordance with embodiments of the present invention, it may be seen that a variety of shapes may be utilized to capture produce. For example, a planar shape 502, a multi-planar shape 504 and 506, an arcuate shape 508, and a cupped shape (not shown) may be utilized without departing from the present invention. Different shapes of paddles may be desirable in processing different types of produce. For example, in embodiments, produce such as a romaine lettuce head, an iceberg lettuce head, a butterhead lettuce head, a summertime lettuce head, a cabbage head, a bok choy head, an escarole lettuce head, a radicchio lettuce head, a broccoli head, a cauliflower head, a broccoflower head, a celery bunch, and a carrot bunch may be processed utilizing different shaped paddles without limitation. Furthermore, paddles, as utilized herein, may be manufactured from a flexible or semi-flexible polymeric compound in some embodiments. As may be appreciated, a clean and sanitary environment is desirable in food processing systems. As such,

6

some polymeric compounds, such as polyurethane may be useful in providing a sanitary capture device. In other embodiments, a stainless steel paddle may be provided. It may be noted that the illustrated embodiments in FIG. 5 are provided for clarifying embodiments and should not be construed as limiting with respect to dimension, shape, or material.

Returning to FIG. 1, produce processing apparatus 100 further includes a conveyor system 112, which may be utilized for moving produce the various systems. Any conveyor system known in the art may be utilized without departing from the present invention. In addition, conveyance systems may be powered by drives such as: an internal combustion engine, an electric motor, a compressed air motor, a hydraulic fluid motor, a wind turbine motor, and a power take off (PTO) motor without limitation and without departing from the present invention. Produce processing apparatus 100 may be further configured with alignment bar 114 for aligning a produce head in order to properly and accurately process the produce.

Produce processing apparatus 100 may be further configured with counter-rotating compression belt system 130. Counter-rotating compression belt system 130 may be configured to apply a compressive force to produce in order to secure the produce. Sufficient compressive forces should be applied to secure the produce without damaging the produce. As may be appreciated, different produce will require different compressive force to obtain production objectives. For example, a head of leafy produce may require less compressive force than a head of dense produce such as broccoli. As such, counter-rotating compression belt system 130 may be configured with an adjustment mechanism for adjusting compressive forces in some embodiments. In some embodiments, a compressive force in a range of approximately 1 to 40 pounds of downward force may be applied to produce by counter-rotating compression belt system 130. In addition, it may be desirable, in some embodiments, to increase compressive force on produce to account for loss of produce material during processing. As such, compressive force may be increased from a first compressive force in a range of approximately 1 to 40 pounds of downward force to a second compressive force in a range of approximately 5 to 60 pounds of downward force.

Counter-rotating compression belt system 130 may also be configured to move synchronously with conveyor system 112. Synchronous movement ensures that produce may be stabilized for processing. However, in other embodiments, asynchronous movement may be desired when processing requires some rotation of the produce. In those asynchronous embodiments, one or more counter-rotating compression belt systems may be utilized to alternately stabilize and rotate produce. Belts utilized in counter-rotating compression belt systems may be manufactured from a flexible or semi-flexible polymeric compound in some embodiments. As may be appreciated, a clean and sanitary environment is desirable in food processing systems. As such, some polymeric compounds, such as polyurethane or TEFLON™ may be useful in providing a belt for use in counter-rotating compression belt systems without limitation. In other embodiments, a non-corrosive metal belt such as stainless steel belt may be provided without limitation. In other embodiments, a metal coated belt may be provided without limitation. In still other embodiments, a rubber or rubberized belt may be provided without limitation. As above, counter-rotating compression belt systems may be powered by drives such as: an internal combustion engine, an electric motor, a compressed air motor, a hydraulic fluid motor, a wind turbine motor, and a

7

power take off (PTO) motor without limitation and without departing from the present invention. In some embodiments, counter-rotating compression belt systems may be mechanically linked to conveyor systems by means of a gear box or chain such that coordinated movement of the systems may be readily achieved.

Produce processing apparatus **100** may be further configured with a cutting system including a number of cutting blades **120** and **122** for coring and trimming produce. As illustrated blades **120** and **122** are rotating blades. Rotating blades may have some advantages over other methods of processing because blades may be easily serviced to provide clean coring and trimming. In some embodiments, rotating blades may further include a safety shroud (not shown) in order to provide a safe working environment for operators of produce processing apparatus **100**. However, in some embodiments, other methods of coring and trimming may be utilized. For example, in some embodiments, a linear action blade, a static blade, a metal wire blade, a laser blade, and a water blade may be utilized without departing from the present invention. As above, counter-rotating cutting blades may be powered by drives such as: an internal combustion engine, an electric motor, a compressed air motor, a hydraulic fluid motor, a wind turbine motor, and a power take off (PTO) motor without limitation and without departing from the present invention.

Produce processing apparatus **100** may be further configured with a rinse system (not shown). It may be appreciated that rinsing produce after processing may be desirable to remove cull or other debris such as insects and soil. Thus, any rinse system known in the art may be utilized without departing from the present invention. In addition, any type of rinse may be utilized including a water rinse, a saline rinse, a chemical rinse, and an air rinse without departing from the present invention.

As produce production becomes more automated, methods of detecting viable produce may be required. In some embodiments, an optical detection device may be utilized to determine viability. These devices may be used before processing when produce is captured by produce processing apparatus **100**, after produce is processed by produce processing apparatus **100**, or both in some embodiments. Utilization of an optical detection device may improve and assure quality control in some embodiments. As such, any optical detection device known in the art may be utilized without departing from the present invention. In addition, a produce rejection system may be utilized in coordination with an optical detection device to remove produce from produce processing apparatus when the produce is not viable. In some embodiments, a produce rejection system may mechanically eject produce from the apparatus. In other embodiments, an alarm may inform an operator that produce is not viable. In still other embodiments, a log may be recorded to track rejected produce.

When processing is complete, produce may be released from produce processing apparatus **100** at a collection point **140**. At that point, produce may be processed or transported in any number of ways. It may be appreciated that by produce processing apparatus **100** may be utilized in the field or out of field without departing from the present invention. Furthermore, embodiments of produce processing apparatus **100** may be truck mounted, trailer mounted, boom mounted, or tractor mounted without limitation. Still further, embodiments may be utilized in coordination with other automated production machinery such as a harvesting machine without limitation.

8

FIG. **2** is an illustrative flowchart **200** of methods for processing produce in accordance with embodiments of the present invention. FIG. **2** will be discussed with FIGS. **3A-B**, which are illustrative representations of side views of a produce processing apparatus during processing in accordance with embodiments of the present invention and with FIG. **4**, which is an illustrative representation of a unit of processed produce in accordance with embodiments of the present invention. At a first step **202**, the method receives a severed produce head on a rotating conveyor system. A severed produce head may be received from automated harvesting machinery or from harvesting personnel without limitation. Referring briefly to FIGS. **3A-B** and **4**, a produce head **402** is received by rotating conveyor system **310** at or around location **302**. As illustrated, each produce head is isolated. Returning to FIG. **2**, at a next step **204**, produce head is aligned. As noted above, produce processing apparatus embodiments may be configured with an alignment bar for aligning a produce head in order to properly and accurately process the produce. In some embodiments alignment may be manually achieved by operators.

At a next step **206**, the severed head may be captured by a counter-rotating compression belt system (see **312**, FIGS. **3A-B**). As noted above, counter-rotating compression belt systems may be configured to move synchronously with conveyor systems. Synchronous movement ensures that produce may be stabilized for processing. However, in some embodiments, asynchronous movement may be desired when processing requires some rotation of the produce. At a next step **208**, the method determines whether to reject a severed produce head. As noted above, optical detection systems may be utilized in some embodiments to detect viability of produce. In some embodiments, produce may be inspected by an operator. Therefore, if the method determines at a step **208** to reject a severed produce head, the method continues to a step **210** to eject the severed produce head from the conveyor system whereupon the method ends. If the method determines at a step **208** not to reject a severed produce head, the method continues to a step **212** to transport the severed produce head through a cutting system.

At a next step **214**, the method trims the severed produce head (see **304**, FIGS. **3A-B**; **404** FIG. **4**). Trimming, as utilized herein removes a top portion of a head. The removed portion is called cull. Trimming may be adjustably configured to remove any amount of cull from the severed head depending on production requirements. Typically, processing removes only portions that may be unsightly or undesirable to a consumer. In some embodiments, trimming removes additional cull by making an angled cut to remove a side portion with respect to the top of the severed head. At a next step **216**, the method cores the severed produce head (see **306**, FIGS. **3A-B**; **406** FIG. **4**). Coring, as utilized herein, refers to removal of a bottom portion of the head. As above, the removed portion is called cull. Coring may be adjustably configured to remove any amount of cull from the severed head depending on production requirements. In some embodiments, a core may be removed leaving a "V" shaped cut. In other embodiments, a core may be removed leaving a straight cut. In still other embodiments, a core may be removed leaving a semi-arcuate or arcuate cut. As noted above, rotating blades, as illustrated here, may have some advantages over other methods of processing because blades may be easily serviced to provide clean coring and trimming. In some embodiments, rotating blades may further include a safety shroud in order to provide a safe working environment for operators of produce processing apparatus. However, in some embodiments, other methods of coring and trimming

may be utilized. For example, in some embodiments, a linear action blade, a static blade, a metal wire blade, a laser blade, and a water blade may be utilized without departing from the present invention.

It may be appreciated that trimming and coring requirements may depend in part upon the type of produce being processed. As noted above, a number of types of produce may be processed utilizing methods described herein. For example, in embodiments, produce such as a romaine lettuce head, an iceberg lettuce head, a butterhead lettuce head, a summertime lettuce head, a cabbage head, a bok choy head, an escarole lettuce head, a radicchio lettuce head, a broccoli head, a cauliflower head, a broccoflower head, a celery bunch, and a carrot bunch may be processed without limitation.

At a next step **218**, the method rinses a trimmed and cored produce head. It may be appreciated that rinsing produce after processing may be desirable to remove cull or other debris such as insects and soil. Thus, any rinse system known in the art may be utilized without departing from the present invention. In addition, any type of rinse may be utilized including a water rinse, a saline rinse, a chemical rinse, and an air rinse without departing from the present invention. At a next step **220**, the method determines whether to reject a trimmed and cored produce head. As noted above, optical detection systems may be utilized in some embodiments to detect viability of produce. In some embodiments, produce may be inspected by an operator. Therefore, if the method determines at a step **220** to reject a trimmed and cored produce head, the method continues to a step **222** to eject the trimmed and cored produce head from the conveyor system whereupon the method ends. If the method determines at a step **220** not to reject a trimmed and cored produce head, the method continues to a step **224** to release the trimmed and cored produce head to a collection point.

Additional Embodiments

As noted above, FIG. 2 is an illustrative flowchart **200** of methods for processing produce in accordance with embodiments of the present invention. FIG. 2 will now be discussed with FIGS. 6A-B, which are illustrative representations of side views of a produce processing apparatus during processing in accordance with embodiments of the present invention and with FIG. 7, which is an illustrative representation of a unit of processed produce in accordance with embodiments of the present invention. At a first step **202**, the method receives a severed produce head on a rotating conveyor system. A severed produce head may be received from automated harvesting machinery or from harvesting personnel without limitation. Referring briefly to FIGS. 6A-B and 7, a produce head **702** is received by rotating conveyor system **610** at or around location **602**. As illustrated, each produce head is isolated by a number of paddles **618**. Returning to FIG. 2, at a next step **204**, produce head is aligned. As noted above, produce processing apparatus embodiments may be configured with an alignment bar **614** for aligning a produce head in order to properly and accurately process the produce. In some embodiments alignment may be manually achieved by operators.

At a next step **206**, the severed head may be compressed by a counter-rotating compression belt system (see **612**, FIGS. 6A-B) by applying a compressive force to a severed produce so that the severed produce is secured without damaging the severed produce. As noted above, counter-rotating compression belt systems may be configured to move synchronously with conveyor systems. Synchronous movement ensures that produce may be stabilized for processing. However, in some embodiments, asynchronous movement may be desired when processing requires some rotation of the produce. At a next

step **208**, the method determines whether to reject a severed produce head. As noted above, optical detection systems may be utilized in some embodiments to detect viability of produce. In some embodiments, produce may be inspected by an operator. Therefore, if the method determines at a step **208** to reject a severed produce head, the method continues to a step **210** to eject the severed produce head from the conveyor system whereupon the method ends. If the method determines at a step **208** not to reject a severed produce head, the method continues to a step **212** to transport the severed produce head through a cutting system.

At a next step **214**, the method trims the severed produce head (see **604**, FIGS. 6A-B; **704** FIG. 7). Trimming, as utilized herein removes a top portion of a head utilizing a rotary trimming blade assembly in embodiments. The removed portion is called cull. Trimming may be adjustably configured to remove any amount of cull from the severed head depending on production requirements. Typically, processing removes only portions that may be unsightly or undesirable to a consumer. In some embodiments, trimming removes additional cull by making an angled cut to remove a side portion with respect to the top of the severed head. At a next step **216**, the method cores the severed produce head (see **606**, FIGS. 6A-B; **706** FIG. 7). Coring, as utilized herein, refers to removal of a bottom portion of the head utilizing a rotary coring blade assembly in embodiments. As above, the removed portion is called cull. Coring may be adjustably configured to remove any amount of cull from the severed head depending on production requirements. In some embodiments, a core may be removed leaving a "V" shaped cut. In other embodiments, a core may be removed leaving a straight cut. In still other embodiments, a core may be removed leaving a semi-arcuate or arcuate cut. As noted above, rotating rotary blades, as illustrated here, may have some advantages over other methods of processing because blades may be easily serviced to provide clean coring and trimming. In some embodiments, rotating rotary blades may further include a safety shroud in order to provide a safe working environment for operators of produce processing apparatus.

It may be appreciated that trimming and coring requirements may depend in part upon the type of produce being processed. As noted above, a number of types of produce may be processed utilizing methods described herein. For example, in embodiments, produce such as a romaine lettuce head, an iceberg lettuce head, a butterhead lettuce head, a summertime lettuce head, a cabbage head, a bok choy head, an escarole lettuce head, a radicchio lettuce head, a broccoli head, a cauliflower head, a broccoflower head, a celery bunch, and a carrot bunch may be processed without limitation.

At a next step **218**, the method rinses a trimmed and cored produce head. It may be appreciated that rinsing produce after processing may be desirable to remove cull or other debris such as insects and soil. Thus, any rinse system known in the art may be utilized without departing from the present invention. In addition, any type of rinse may be utilized including a water rinse, a saline rinse, a chemical rinse, and an air rinse without departing from the present invention. At a next step **220**, the method determines whether to reject a trimmed and cored produce head. As noted above, optical detection systems may be utilized in some embodiments to detect viability of produce. In some embodiments, produce may be inspected by an operator. Therefore, if the method determines at a step **220** to reject a trimmed and cored produce head, the method continues to a step **222** to eject the trimmed and cored produce head from the conveyor system whereupon the method ends. If the method determines at a step **220** not to reject a trimmed

11

and cored produce head, the method continues to a step **224** to release the trimmed and cored produce head to a collection point.

In order to more clearly illustrate embodiments of the present invention, FIGS. **8 A-B**, which are illustrative representations of side views of a cutting system in accordance with embodiments of the present invention are presented. In particular, FIGS. **8A-B** illustrate selected portions of FIGS. **6A-B**. In addition, FIG. **9**, which is an illustrative representation of a unit of processed produce in accordance with embodiments of the present invention, is presented. As illustrated in FIG. **8A**, cutting system **800** includes rotary trimming blade assembly **820** positioned along a path of the rotating conveyor system, which assembly includes trimming blade **802** mechanically coupled with rotatable trimming shaft **808** by proximal attachment point and distal attachment point **806**. In embodiments, one or more trimming blade may be utilized. In embodiments, utilizing a single trimming blade, a trimming counterweight may be coupled with the rotatable trimming shaft for balancing the cutting system. Additionally, as illustrated, two similar trimming blade shapes may be utilized. However, trimming blades may also include dissimilar and complementary blade shapes. Example trimming blade shapes will be discussed in further detail below for FIG. **10**. Because different trimming blade shapes may be configured, resulting trimming shapes may include, without limitation, a vee shape, an arcuate shape, a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape in embodiments. In embodiments, trimming blades are configured to remove a top portion of produce **904** (FIG. **9**).

Further, as illustrated, trimming drive **810** may be coupled with rotatable trimming shaft **808** for driving trimming blade **802** through a rotational path. Any number of drives may be utilized in embodiments including an internal combustion engine, an electric motor, a compressed air motor, a hydraulic fluid motor, a wind turbine motor, and a power take off (PTO) motor. In addition, in embodiments, mechanical coupling may be accomplished utilizing a belt drive (illustrated), a gear drive, a chain drive, and a direct drive. Further, in embodiments, trimming drive **810** may be configured to rotate trimming blade in a range of approximately 50 to 10000 RPM. Cutting system **800** may include vertical adjustment **812** for adjusting the height of trimming blade **802** with respect to produce **902** (FIG. **9**) being processed.

As illustrated in FIG. **8B**, cutting system **850** includes rotary coring blade assembly **870** positioned along a path of the rotating conveyor system, which assembly includes coring blade **852** mechanically coupled with rotatable coring shaft **858** by proximal attachment point and distal attachment point **856**. In embodiments, one or more coring blade may be utilized. In embodiments, utilizing a single coring blade, a coring counterweight may be coupled with the rotatable coring shaft for balancing the cutting system. Additionally, as illustrated, two similar coring blade shapes may be utilized. However, coring blades may also include dissimilar and complementary blade shapes. Example coring blade shapes will be discussed in further detail below for FIG. **10**. Because different coring blade shapes may be configured, resulting coring shapes may include, without limitation, a vee shape, an arcuate shape, a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape in embodiments. In embodiments, coring blades are configured to remove a bottom portion of produce **906** (FIG. **9**).

Further, as illustrated, coring drive **810** may be coupled with rotatable coring shaft **858** for driving coring blade **852** through a rotational path. Any number of drives may be

12

utilized in embodiments including an internal combustion engine, an electric motor, a compressed air motor, a hydraulic fluid motor, a wind turbine motor, and a power take off (PTO) motor. In addition, in embodiments, mechanical coupling may be accomplished utilizing a belt drive (illustrated), a gear drive, a chain drive, and a direct drive. Further, in embodiments, coring drive **860** may be configured to rotate coring blade in a range of approximately 50 to 10000 RPM. Cutting system **850** may include vertical adjustment **862** for adjusting the height of coring blade **852** with respect to produce **902** (FIG. **9**) being processed.

FIG. **10** are illustrative representations of coring and trimming blade assemblies in accordance with embodiments of the present invention. As contemplated by embodiments described herein, coring and trimming blade assemblies are substantially similar in function. That is, removing a portion of produce. While the assemblies are similar in function, they may differ in form as may be seen in the illustrated embodiments. As such, the description provided for rotary coring blade assembly **1010** may be equally applied to assemblies **1100** to **1140** (FIG. **11**). The illustrated embodiments are provided for clarity in various examples, but should not be construed as limiting. Indeed, any number of forms for blade assemblies may be utilized without departing from embodiments provided herein. Indeed, as illustrated, two similar blade shapes may be utilized. However, blades may also include dissimilar and complementary blade shapes. Because different blade shapes may be configured, resulting coring shapes may include, without limitation, a vee shape, an arcuate shape, a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape in embodiments.

As illustrated, rotary coring blade assembly **1010** includes rotatable coring shaft **1022**, which shaft rotates about axis of rotation **1028**. Coupling members **1014** and **1016** may be configured for receiving at least one coring blade. As illustrated in one embodiment, two coring blades may be attached with coupling members. Coupling member **1014** includes proximal attachment point **1012** which may include a clamping mechanism for easy assembly and removal of coring blade **1020**. In some embodiments attachment may be effected by bolting, riveting, or welding without limitation. Likewise coupling member **1016** includes distal attachment point **1018** which may include a clamping mechanism for easy assembly and removal of coring blade **1020**. Coupling blade **1020** may be configured with coring blade edge **1024**, which edge may be aligned along a core blade leading edge. As may be seen from direction of rotation **1026**, core blade edge may contact produce **1034** to produce a coring shape **1032** thereby coring the produce. As noted above, in embodiments, coring shapes may include a vee shape, an arcuate shape, a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape. In addition, as is well known in the food processing arts, it is generally desirable to utilize materials that are easily cleaned and sterilized. As such, in embodiments, coring blades may be manufactured from stainless steel compositions, epoxy resin compositions, and polymeric compositions without limitation.

As illustrated, rotary trimming blade assembly **1040** includes rotatable trimming shaft **1052**, which shaft rotates about axis of rotation **1058**. Coupling members **1044** and **1046** may be configured for receiving at least one trimming blade. As illustrated in one embodiment, two trimming blades may be attached with coupling members. Coupling member **1044** includes proximal attachment point **1042** which may include a clamping mechanism for easy assembly and removal of trimming blade **1050**. In some embodiments attachment may be effected by bolting, riveting, or welding

13

without limitation. Likewise coupling member **1046** includes distal attachment point **1048** which may include a clamping mechanism for easy assembly and removal of trimming blade **1050**. Trimming blade **1050** may be configured with trimming blade edge **1054**, which edge may be aligned along a trim blade leading edge. As may be seen from direction of rotation **1056**, trim blade edge may contact produce **1064** to produce a trimming shape **1062** thereby trimming the produce. As noted above, in embodiments, trimming shapes may include a vee shape, an arcuate shape, a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape. In addition, as is well known in the food processing arts, it is generally desirable to utilize materials that are easily cleaned and sterilized. As such, in embodiments, trimming blades may be manufactured from stainless steel compositions, epoxy resin compositions, and polymeric compositions without limitation.

FIG. **11** is an illustrative representation of trimming blade assemblies in accordance with embodiments of the present invention. As illustrated, rotary trimming blade assembly **1100** provides a diagonal shape for a produce, which shape may be formed across a produce or across a portion of a produce (illustrated). Likewise rotary trimming blade assembly **1110** provides a diagonal shape for a produce, which shape may be formed across a produce or across a portion of a produce (illustrated). Further as illustrated, trimming blade assemblies **1120** and **1130** may produce a vee shape. Rotary trimming blade assembly **1120** represents two complimentary blades which may result in a complimentary trim shape. Still further as illustrated, trimming blade assembly **1140** may produce an arcuate shape. In other embodiments, trim shapes may include without limitation a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape. In some examples, rotary coring blade assemblies and rotary trimming blade assemblies may be interchangeable. As noted above, embodiments may be utilized to process a variety of produce including, a romaine lettuce head, an iceberg lettuce head, a butterhead lettuce head, a summertime lettuce head, a cabbage head, a bok choy head, an escarole lettuce head, a radicchio lettuce head, a broccoli head, a cauliflower head, a broccoflower head, a celery bunch, and a carrot bunch without limitation.

As may be appreciated, alternative conveyance methods may be utilized with coring and trimming blade assemblies as disclosed above without departing from embodiments disclosed herein. For example, FIG. **12** is an illustrative representation **1200** of coring and trimming blade assemblies in accordance with embodiments of the present invention. As noted above, conveyances utilizing compression systems may be configured to convey and secure produce without damaging tender portions of the produce. An alternative method of conveyance may include the utilization of annular cups. As utilized herein, the term annular cup refers generally to an annular surface tapered and sized to secure produce during processing. In some embodiments, annular cups may have a circular cross-sectional profile. In other embodiments, cross-sectional profiles include a triangular cross-section, a rectangular cross-section, a pentagonal cross-section, a hexagonal cross-section, and an ovate cross-section. As illustrated, annular cup **1202** may be utilized to secure produce **1210**. A number of annular cups may be attached with belt **1204**, which may be driven by any means known in the art without departing from embodiments disclosed herein. In some embodiments, a linkage such as a chain or other flexible member may be utilized without limitation. An illustrative representation of produce **1240** is illustrated, which representation is rotated 90° with respect to produce **1210** for clarity.

14

Once produce is secured, annular cups may be conveyed across a path such that produce is brought into contact range of trimming blade assembly **1212**, which assembly makes trim **1214** thereby creating a trim shape. In embodiments, trimming shapes may include a vee shape, an arcuate shape, a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape. An illustrative representation of trimmed produce **1242** is illustrated, which representation is rotated 90° with respect to produce **1210** for clarity. Once produce is trimmed, annular cups may be conveyed across a path such that produce is brought into contact range of coring blade assembly **1216**, which assembly makes core **1218** thereby creating a core shape. In embodiments, coring shapes may include a vee shape, an arcuate shape, a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape. An illustrative representation of trimmed produce **1244** is illustrated, which representation is rotated 90° with respect to produce **1210** for clarity. It may be noted that although the illustrated apparatus trims first, then cores, embodiments may further include coring first and then trimming or may accomplish trimming and coring at the same time. Furthermore, in the configuration illustrated, produce is positioned vertically with respect to the path of processing. In other embodiments, produce may be rotated to the horizontal with respect to the path of processing whereby coring and trimming apparatuses may be horizontally mounted as in FIGS. **8A** and **8B**.

In order to more clearly illustrate an embodiment as depicted in FIG. **12**, FIG. **13** is an illustrative representation **1300** of coring and trimming blade assemblies in accordance with embodiments of the present invention. In particular, FIG. **13** is a 90° rotation of FIG. **12**. Thus, as may be seen produce **1310** is secured by annular cup **1302**. Once produce is secured, annular cups may be conveyed across a path such that produce is brought into contact range of trimming blade assembly **1312** and coring blade assembly **1316**. As illustrated, embodiments remove a portion of produce prior to packaging or further processing. In the illustration, trimming and coring blade assemblies include a belt driven mechanism, however, as above, any drive mechanism may be utilized in embodiments without limitation. As such, any number of drives may be utilized in embodiments including an internal combustion engine, an electric motor, a compressed air motor, a hydraulic fluid motor, a wind turbine motor, and a power take off (PTO) motor. In addition, in embodiments, mechanical coupling may be accomplished utilizing a belt drive (illustrated), a gear drive, a chain drive, and a direct drive.

While this invention has been described in terms of several embodiments, there are alterations, permutations, and equivalents, which fall within the scope of this invention. It should also be noted that there are many alternative ways of implementing the methods and apparatuses of the present invention. Furthermore, unless explicitly stated, any method embodiments described herein are not constrained to a particular order or sequence. For example, trimming and coring may be performed in any order without departing from the present invention. Still further, optical scanning of produce may be performed at any stage during production. Further, the Abstract is provided herein for convenience and should not be employed to construe or limit the overall invention, which is expressed in the claims. It is therefore intended that the following appended claims be interpreted as including all such alterations, permutations, and equivalents as fall within the true spirit and scope of the present invention.

15

What is claimed is:

1. A produce processing apparatus comprising:

a plurality of paddles coupled with a rotating conveyor system, the plurality of paddles configured for capturing and securing produce along a first position of the rotating conveyor system;

a counter-rotating compression belt system for compressing the produce along a second position of the rotating conveyor system, wherein

the counter-rotating compression belt system is configured to apply a compressive force to the produce such that the produce is secured between the rotating conveyor system and

the counter-rotating compression belt system without damaging the produce, and wherein the counter-rotating compression belt system includes a belt that is counter rotating and synchronized with respect to the rotating conveyor system; and

a cutting system comprising a rotary coring blade assembly positioned along a path of the rotating conveyor system, wherein the rotary coring blade assembly further comprises:

at least two coring blades, the at least two coring blades each including a core blade edge aligned along a middle portion of each of the at least two coring blades, wherein the middle portion is formed to provide a first coring shape to core the produce, and wherein each of the at least two coring blades further include,

a first proximal attachment point positioned along a proximal end of each of the at least two coring blades for attaching each of the at least two coring blades with a rotatable coring shaft that rotates about an axis of rotation, wherein the first proximal attachment point removeably couples with the rotatable coring shaft by a first coupling member; and

a first distal attachment point positioned along a distal end of each of the at least two coring blades for attaching each of the at least two coring blades with the rotatable coring shaft wherein the first distal attachment point removeably couples with the rotatable coring shaft by a second coupling member such that each of the at least two coring blades is positioned parallel with the rotatable coring shaft, wherein, each of the at least two coring blades are coupled with the rotatable coring shaft, wherein

each of the at least two coring blades define a void with respect to the rotatable coring shaft, and wherein the rotary coring blade assembly is positioned and configured to core the produce along a third position of the rotating conveyor system.

2. The apparatus of claim 1, wherein the cutting system further comprises:

a coring drive in mechanical communication with the rotatable coring shaft for driving the at least two coring blades through a rotational path.

3. The apparatus of claim 1, further comprising:

a coring counterweight coupled with the rotatable coring shaft for balancing the cutting system when only one coring blade is utilized.

4. The apparatus of claim 1, wherein the first coring shape and the second coring shape is a shape selected from the group consisting of: a vee shape, an arcuate shape, a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape.

16

5. The apparatus of claim 1, further comprising:

a rotary trimming blade assembly positioned along the path of the rotating conveyor system, the rotary trimming blade assembly including,

at least one trimming blade, wherein the at least one trimming blade further comprises:

at least one trim blade edge aligned along a trim blade leading edge of a second portion of the at least one trimming blade, wherein the second portion is formed to provide a first trimming shape to trim the produce, a second proximal attachment point for attaching the at least one trimming blade with a rotatable trimming shaft, and

a second distal attachment point for attaching the at least one trimming blade with the rotatable trimming shaft, wherein the rotatable trimming shaft comprises a plurality of coupling members for securing the at least one trimming blade at the second proximal attachment point and the second distal attachment point.

6. The apparatus of claim 2, wherein the cutting system further comprises:

a trimming drive in mechanical communication with the rotatable trimming shaft for driving the at least one trimming blade through a rotational path.

7. The apparatus of claim 6, wherein the coring drive and the trimming drive are selected from the group consisting of an internal combustion engine, an electric motor, a compressed air motor, a hydraulic fluid motor, a wind turbine motor, and a power take off (PTO) motor, wherein the trimming drive is configured to rotate trimming blade in a range of approximately 50 to 10000 RPM.

8. The apparatus of claim 5, further comprising:

a trim counterweight coupled with the rotatable trimming shaft for balancing the cutting system when only one trimming blade is utilized.

9. The apparatus of claim 5, wherein the first trimming shape and the second trimming shape is a shape selected from the group consisting of: a vee shape, an arcuate shape, a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape.

10. The apparatus of claim 1, further comprising:

a rinse system along a fourth position for rinsing a trimmed and cored produce, wherein the rinse system includes a rinse selected from the group consisting of: a water rinse, a saline rinse, a chemical rinse, and an air rinse.

11. The apparatus of claim 1, further comprising:

a first optical detection device along the first position for detecting viability of the produce, the optical detection device configured to function in coordination with a first produce rejection system along the first position, wherein the produce is removed from the rotating conveyor system if the produce is not viable.

12. The apparatus of claim 1, further comprising:

a second optical detection device along fourth position for detecting viability of the produce, the optical detection device configured to function in coordination with a second produce rejection system wherein the produce is removed from the rotating conveyor system if the produce is not viable.

13. A produce processing apparatus comprising:

a plurality of annular cups coupled with a rotating conveyor system configured for capturing and securing produce along a first position of the rotating conveyor system; and

a cutting system comprising,

a rotary coring blade assembly positioned along a path of the rotating conveyor system, wherein the rotary

17

coring blade assembly is positioned and configured to core the produce along a second position of the rotating conveyor system, wherein the rotary coring blade assembly further comprises:

- at least two coring blades, the at least two coring blades each including a core blade edge aligned along a middle portion of each of the at least two coring blades, wherein the middle portion is formed to provide a first coring shape to core the produce, and wherein each of the at least two coring blades further include,
- a first proximal attachment point positioned along a proximal end of each of the at least two coring blades for attaching each of the at least two coring blades with a rotatable coring shaft that rotates about an axis of rotation, wherein the first proximal attachment point removeably couples with the rotatable coring shaft by a first coupling member, and
- a first distal attachment point positioned along a distal end of each of the at least two coring blades for attaching each of the at least two coring blades with the rotatable coring shaft wherein the first distal attachment point removeably couples with the rotatable coring shaft by a second coupling member such that each of the at least two coring blades is positioned parallel with the rotatable coring shaft, wherein, the at least two coring blades are coupled with the rotatable coring shaft, wherein

18

each of the at least two coring blades define a void with respect to the rotatable coring shaft, and a rotary trimming blade assembly positioned along the path of the rotating conveyor system, wherein the rotary trimming blade assembly is positioned and configured to core the produce along a third position of the rotating conveyor system.

14. The apparatus of claim 13, wherein

the rotary trimming blade assembly further comprises:

- at least one trim blade edge aligned along a trim blade leading edge of a second portion of the at least one trimming blade, wherein the second portion is formed to provide a trimming shape to trim the produce,
- a second proximal attachment point for attaching the at least one trimming blade with a rotatable trimming shaft that rotates about an axis of rotation, and
- a second distal attachment point for attaching the at least one trimming blade with the rotatable trimming shaft such that the at least one trimming blade is positioned parallel with the rotatable coring shaft, wherein the rotatable trimming shaft comprises a plurality of coupling members for securing the at least one trimming blade at the second proximal attachment point and the second distal attachment point.

15. The apparatus of claim 13, wherein the coring shape and the trimming shape is a shape selected from the group consisting of: a vee shape, an arcuate shape, a semi-arcuate shape, a rectangular shape, and a semi-rectangular shape.

* * * * *